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XIX. On the temperature at considerable depths of the Caribbean Sea. By Captain EDWARD SABINE, F.R.S., in a Letter addressed to Sir HUMPHRY DAVY, Bart. Pres. R.S.

Read April 17, 1823.

MY DEAR SIR,

WHEN I last quitted England, you did me the favour to direct my attention to the temperature at considerable depths of fresh water lakes within the tropics, or of basins of salt water out of the reach of currents from the polar regions, and in climates where the lowest temperature of the superincumbent atmosphere is above 42° . as the point of the greatest density of water; viewing such knowledge in reference to the important question of the high temperature of the interior of the globe.

It has been a subject of continual regret to me, that situations in which the experiment could be tried, under circumstances which would alone render it decisive of the point in question, are of such rare occurrence, that not a single opportunity has presented itself to me on either side of the Atlantic, of carrying your suggestion into effect. As, however, it gave occasion to an attempt to ascertain the temperature of the Caribbean sea, at a depth beyond the means of sounding with which ships are usually provided, I may be permitted to take this mode of acquainting you of the result.

The Caribbean and Mexican seas, near the junction of which the experiment was made, approach the nearest, perhaps, to the character of insulated and deep basins of salt

water of any detached portions of the main ocean within the tropics; whilst however the connection is preserved, and by deep sea channels, it could scarcely be doubted, that if the colder water of distant regions finds its way to the equatorial parallels of the main ocean, it would no less pervade the corresponding depths in the same parallels, wheresoever a communication existed to admit its passage: if such an opinion required confirmation, it appears to have received it by the result of the present experiment.

A transcript of the memorandum which I wrote at the time, may probably be deemed the most satisfactory mode of relation.

“ H. M. S. Pheasant, on passage between Grand Cayman Island and Cape St. Antonio, in Cuba, lat. $20\frac{1}{2}$ N. lon. $83\frac{1}{2}$ W., November 13th, 1822.

“ At 2 P.M. hove too, and sounded with 1230 fathoms of line, being 11 coils of 113 fathoms each, and three fathoms of a 12th coil; at the end of the line was attached a strong iron cylinder of 75 lbs. weight, enclosing a Six's self-registering thermometer: the top of the cylinder screwed down upon leather, being designed, by excluding the water from the interior, to obviate any effect which might be supposed to arise from the increased pressure of water at great depths: the thermometer fitted into spiral springs at the top and bottom, which kept it from contact with other parts of the cylinder, and preserved it from injury, in case the apparatus should accidentally strike against the sides of the ship, or against rocks at the bottom: another iron cylinder, of much less strength and weight than the preceding, was attached two fathoms above the end of the line, and being pierced

with holes in the top and bottom, admitted free access of the water to a second thermometer, of similar construction to the first. The opportunity was very favourable for the object, the weather being fine, with light airs and but little swell: the 1230 fathoms run out in rather more than 25 minutes, at the expiration of which time the line was fairly on the quarter, the ship's drift having been bodily to leeward, without her having had either head or stern way; there was consequently much less stray line than had been anticipated. The best practical judgment which Captain CLAVERING could form on the spot was, that the depth to which the thermometers had actually attained must have exceeded a thousand fathoms, as an allowance of the remaining 230 fathoms for stray line would certainly be more than ample, if no bight of consequence existed in the rope, which, from the appearance, and from the rapidity with which the weight drew out the line, might be judged the case: 230 fathoms would equal a drift to leeward of $\frac{4}{5}$ ths of a mile in 25 minutes, whereas that of the ship did not exceed $\frac{1}{2}$ a mile an hour; it is more than probable, therefore, that the depth is underrated when it is estimated at 1000 fathoms, or 6000 feet. The line was hauled in in 53 minutes, and the thermometers came up in good order; the one in the cylinder to which the water had free access had registered $45^{\circ},5$; the attempt to exclude the water from the other cylinder did not in this instance altogether succeed, in consequence of the top not having been screwed down sufficiently close upon the leather; this thermometer had registered $49^{\circ},5$; the difference of 4° may be attributed, perhaps, partly to the latter not having been so long in contact with the cold water as the other thermometer,

as the water appeared to have had great difficulty, and was probably some time in forcing its way into the interior of the closed cylinder; and partly to the heat which so great a thickness of metal would retain for a considerable time; the surface water was from $82^{\circ},5$ to $83^{\circ},2$ in the course of the afternoon; the difference of temperature between the surface, and a depth exceeding 1000 fathoms was, therefore, $33^{\circ},3$ by one thermometer, and $37^{\circ},3$ by the other, the indication of the latter being entitled to the most reliance.

"It may be reasonably inferred, that one or two hundred fathoms more line would have caused the thermometer to have descended into water at its maximum of density, as depends on heat, below which, consequently, no farther diminution of temperature would take place; this inference being on the presumption that the greatest density of salt water occurs, as is the case in fresh water, at several degrees above its freezing point.

"It is desirable to repeat this experiment, should an opportunity present itself, and to attach several register thermometers, at intervals of the line, to ascertain the progression in which the temperature diminishes; and it would be still more interesting to determine the depth beneath the surface at which water is found, at the term of the diminution of its temperature in different parallels."

The opportunity which was thus hoped for, did not occur in the remainder of the voyage; the experiment requires favourable circumstances of weather, and of sea, to both of which the season was adverse.

I am not aware of any previous experiments on the temperature of the deep sea within the tropics, except those

of Monsieur PERRON, the imperfection of whose apparatus prevented his obtaining equally decisive results. Being unprovided with a registering thermometer, he enclosed one of the ordinary construction in several cases filled with non-conducting substances, in order that the temperature which the thermometer had acquired, by being suffered to remain a sufficient time below, might not be disturbed by its being drawn up through the warmer strata. It appears, however, that in his principal experiment, in which the apparatus was sunk to 2144 feet, the process of raising it lasted three-quarters of an hour, or half the time it had remained below : the difference therefore between the surface and the deep sea water, may be supposed to have been actually greater than would appear in his results ; they are in accord however with the present, in showing even a more rapid decrease of temperature in descending from the surface.

In lat. 5° North, 38° degrees of Fahrenheit less than at the surface at 1200 feet ; and in lat. 4° North, 42 degrees of Fahrenheit less than at the surface at 2144 feet.

The thermometers used in the present Experiment were made expressly for the purpose to which they were applied, and were of the ordinary construction of Six's registering thermometer : the top of the tube, in which is contained the index of heat, was hermetically sealed instead of being closed by a cork, as is sometimes the case. I have no reason to doubt the accuracy of their performance in any respect.

I remain, my dear Sir
your obliged and faithful Servant,

2, *Portland Place*,
March 18, 1823.

EDWARD SABINE.